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The STRIPED CUCUMBER BEETLE

AND HOW TO CONTROL IT

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THE STRIPED CUCUMBER BEETLE is the most destructive of all our cucumber insect pests and does serious damage to all forms of related plants. It is widely distributed east of the Rocky Mountains and is to be found in most fields and gardens.

The adult or beetle is about one-fifth of an inch long, yellow, with three stripes running lengthwise of the wing-covers.

The beetles attack and injure seedling plants as soon as they appear, even burrowing down to meet them before they come above ground. They devour the tender stems and leaflets before the plant is fairly started, gnaw the older stems and ripe fruits, and act as carriers of cucurbit diseases. They make their appearance suddenly and in great numbers, and as they work rapidly an entire crop may be destroyed in a few days.

The young, known as worms or larvæ, although much less destructive than the beetles, injure the plants later in the season by tunneling the roots and underground parts of the stems.

To control this pest and reduce its ravages five methods are employed: Preventive measures, the use of repellent substances, dusting with nicotine dust, spraying and dusting with arsenate of lead, and good farm practice. These are described fully on pages 7 to 15 and summarized on page 16.

This bulletin is a revision of and supersedes Farmers' Bulletin 1038, The Striped Cucumber Beetle and Its Control.

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THE STRIPED CUCUMBER BEETLE[1] AND HOW TO CONTROL IT.

F. H. CHITTENDEN, *Entomologist in Charge, Truck-Crop Insect Investigations, Bureau of Entomology.*

CONTENTS.

	Page.		Page.
Appearance and nature of injury	1	Life history and habits	5
The insect in its different stages	2	Natural enemies	6
Where it occurs	3	Methods of control	7
Food plants	3	Summary of control measures	16

APPEARANCE AND NATURE OF INJURY.

SEEDLING CUCUMBERS are injured by a small yellow and black striped beetle, known locally as "melon bug," "striped bug," and more generally as the striped cucumber beetle. Attack begins at about the time the cucumber plants are 2 or 3 inches high, though not infrequently the beetles appear a little before the plants and burrow into the ground to meet them, afterwards devouring the tender stems and leaflets before the plant is fairly started. The work of the beetle on the first leaves and stems of cucumbers is shown in Figure 1.

FIG. 1.—Young cucumber plants showing severe and characteristic injury by adults of the striped cucumber beetle at end of roots and in the seed leaves.

While the most obvious as well as the principal injury done by this pest is to seedling cucumbers by the overwintered beetles, severe injury is often inflicted on melons, squashes, pumpkins, and related crop plants.

Everything considered, the striped cucumber beetle is the most important insect enemy of cucurbits with which the farmer and gar-

[1] *Diabrotica vittata* Fab.; order Coleoptera, family Chrysomelidae.

dener have to deal, and constant complaints are received every year of its ravages to these crops.

The beetles are destructive to older plants by eating the leaves and by gnawing away and consuming the outer tissues and considerable portions of the stems, and later by devouring the rinds of the fruits and rendering them unmarketable.

The beetles cause further mischief by acting as carriers of the bacterial wilt,[2] mosaic, and other diseases of cucurbits. This is a matter of grave importance and has been the subject of special investigation by the Department of Agriculture since the year 1915.

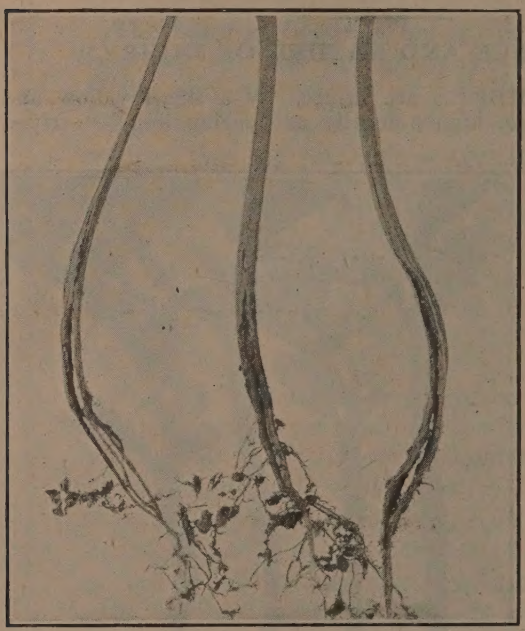

FIG. 2.—Underground stems of cucumber showing injury by larvæ of the striped cucumber beetle.

The larvæ or "worms" also are the cause of injury to older plants through their work underground in the roots and stems (Fig. 2), which they tunnel from below. The larvæ, however, are by no means as destructive as the beetles. Because of the underground feeding habits of the larvæ, more frequently than not the roots of cucurbits are being injured without the knowledge of the farmer or gardener, the outward manifestation of their presence being the wilting of the leaves and the failure of the plants to develop perfect fruit. Far too often the debility or death of the vines through the work of this insect—the larvæ at the roots and the beetles on the stems near the ground—is attributed to wilt, dry weather, or some other than the real cause.

Injury by the striped cucumber beetle, then, is threefold, due (1) to direct attack by the beetles on the plant, (2) indirectly to the beetles as transmitters of diseases, and (3) to the work of the larvæ in destroying the root system.

THE INSECT IN ITS DIFFERENT STAGES.

In the course of its life this insect passes through four stages of development: (1) the egg, (2) the larva or "worm," (3) the pupa or resting stage, and (4) the adult or beetle.

[2] *Bacillus tracheiphilus* Erw. Sm. See Bacterial Wilt of Cucurbits. Frederick V. Rand and Ella M. A. Enlows. U. S. Dept. Agr. Bul. 828, 43 p., 2 tab., 10 fig., 4 pl. 1920.

The adult striped cucumber beetle (Fig. 3, *a*) is about one-fifth of an inch long and nearly half as wide. It is yellow above, with black head and black stripes running lengthwise along each wing-cover, producing the effect of a three-striped back. The abdomen underneath is black, the neck and legs are yellow, and the antennæ, or feelers, are mostly black. The feet and knees are black.

The egg (Fig. 3, *d*) is about one-fortieth of an inch long and about half as wide. In color it is bright lemon yellow to orange. Its surface, as viewed under a high-power microscope, is finely sculptured, arranged in hexagonal pits (Fig. 3, *e*).

The larva (Fig. 3, *b*) is a very slender, white, wormlike creature, with dark-brown head and anal plate and lighter brown thoracic plate. When fully matured its length is about three-tenths of an inch, this being about ten times its width. It is provided in front with three pairs of thoracic or true legs, and behind with an anal

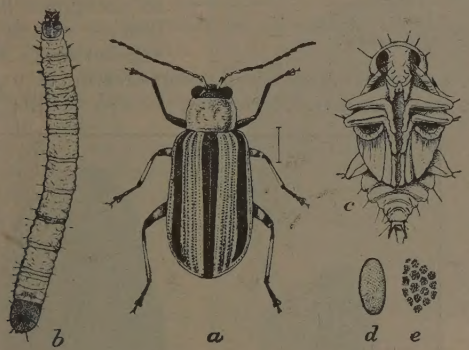

FIG. 3.

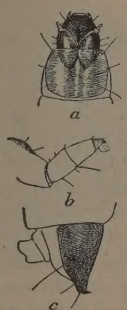

FIG. 4.

FIG. 3.—Striped cucumber beetle: *a*, Beetle; *b*, larva; *c*, pupa; *d*, egg; *e*, sculpture of egg. *a*, *b*, *c*, Much enlarged; *d*, more enlarged; *e*, highly magnified.

FIG. 4.—Striped cucumber beetle: *a*, Head of larva; *b*, leg of same; *c*, last segment from side, showing hind false-leg. All greatly enlarged.

proleg (hind false-leg). Figure 4 shows the head and thoracic plate (*a*), a true leg (*b*), and the anal proleg and anal plate in profile (*c*).

The pupa (Fig. 3, *c*) is of nearly the same color as the larva and its surface is sparsely beset with long spinelike hairs, those on the upper surface or back arising from small but prominent hair-bearing warts.

WHERE IT OCCURS.

The striped cucumber beetle is native to this country and inhabits all parts of the United States east of the Rocky Mountains from Canada to Mexico. The approximate distribution is shown in the accompanying map (Fig. 5).

FOOD PLANTS.

The striped cucumber beetle is by far more common and more destructive than any other cucurbit pest with which the farmer

and gardener have to deal. Hubbard and marrow squashes are its favorite food plants; cucumbers and muskmelons are most severely injured, while pumpkins, gourds, summer squashes, watermelons, and chayotes are also frequently damaged.

FIG. 5.—Map showing approximate distribution of the striped cucumber beetle.

It is not alone in the field and garden that this insect is troublesome, since serious injury is often done in greenhouses by both beetles and larvæ.

So far as known, the larvæ are restricted in their food to cucurbits, but the beetles attack other vegetation. Among these, beans are favorites, the beetles often congregating in numbers upon them, killing the leaves and rendering the pods so unsightly that they are unmarketable. Peas, ripe apples, apple blossoms, and the leaves, silk, pollen, and unripe kernels of corn are also attacked.

FIG. 6.—Striped cucumber beetles feeding on cucumbers after frost has killed the foliage. Natural size.

The beetles naturally are flower feeders and may be found on the large blossoms of the squash and pumpkin as long as they are in bloom. Notwithstanding this, they eat nearly every other portion of a plant, and frequently cause injury to cucurbits by gnawing the rind of the fruit, thus rendering it unfit for market. (See Figs. 6 and 7.)

Among wild plants the beetles are partial to the flowers of goldenrod, aster, and sunflower, devouring the colored portions, stamens, pistils, and ray flowers. In the spring they frequent the young plants of aster[3], goldenrod[4], and great ragweed,[5] and the flowers

[3] Especially *Aster puniceus.* [4] Particularly *Solidago altissima.* [5] *Ambrosia trifida.*

of chokeberry, Juneberry, cherry, and related plants. They feed freely on the prickly cucumber or wild balsam apple,[6] a plant cultivated for ornament and shade. Where observed in the District of Columbia, Maryland, Virginia, Iowa, Indiana, and Wisconsin the beetles make their first appearance on these plants during May and early June.

LIFE HISTORY AND HABITS.

The female beetles lay their eggs, either singly or in groups, in the soil about the roots and stems, frequently placing them in cracks and crevices. The number deposited by a single beetle varies, 1,457 being the highest number observed and between 400 and 500 the average. The eggs hatch in 1 to 2 weeks, the egg period, like all others subject to temperature, being shorter when the weather is warm. The larval life is passed in earth that is somewhat moist, about the base of the stalks, and larvæ may be found within the stems and on the fruit where these come in contact with the earth. This period lasts from 2 to 5 or 6 weeks. Hence there is an active stage of this duration in which the larvæ working in numbers have ample time for injuring the roots and stems.

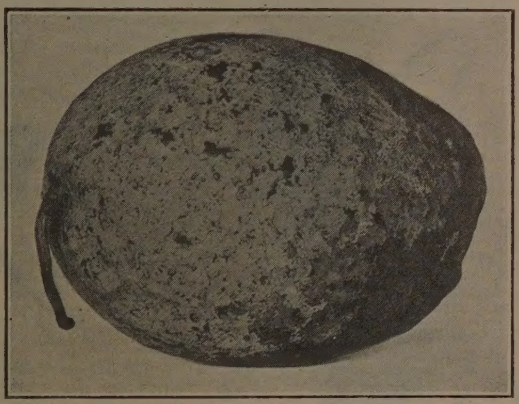

FIG. 7.—Ripe watermelon injured by striped cucumber beetle.

When full grown, the larva contracts and becomes much stouter. This is a preliminary period before the change to pupa and lasts from 2 to 5 days. The pupal period ranges from 5 to 8 days in warm weather to 2 weeks when it is colder.

Adults of the first generation begin to develop as early as the first week in July and continue to appear for several weeks thereafter. The overwintered beetles begin to die toward the end of July, so that there is some overlapping of the two generations.

The entire life cycle covers from 5 or 6 to 8 weeks, but in southern Texas it may be passed in less than 4 weeks. In the District of Columbia it occupies about 6 weeks.

NUMBER OF GENERATIONS.

Only one generation of the striped cucumber beetle annually has been observed in the more northern States. Farther south there are

[6] (*Echinocystis*) *Micrampelis lobata.*

probably two or, exceptionally, three generations, and in southern Texas there may be even four. In the Middle Atlantic States newly transformed beetles occur from the second week in July until the first week in October.

HIBERNATION.

Toward the end of the season, during September and October, in the principal trucking regions, the beetles congregate under the vines and prostrate portions of plants, withered leaves, and abandoned fruits of cucumber, melons, squash, and other cucurbits, hundreds sometimes gathering on a single fruit. Frequently they assemble in great numbers and eat off the rinds of the tender fruits. (See Fig. 6.) They also attack beans and destroy their value for market. After feeding freely, they seek various places of shelter.

FIG. 8.—Back and side view of a fly parasite of adult striped cucumber beetle.

During the first cold nights of October in the District of Columbia the beetles begin to disappear, although hibernation may commence earlier. Just when this usually takes place, and where, has not been determined definitely; but, judging from the fact that the beetles are first seen on aster, goldenrod, and great ragweed along river bottoms, it seems probable that they hibernate in locations where these plants abound.

NATURAL ENEMIES.

The striped cucumber beetle has at least two important insect enemies, and several others have been observed. Adults are frequently destroyed by two kinds of parasitic tachina flies of similar habits, which develop within the abdomen of the host, whence they escape as flies. The first of these [7] has been known for many years and is widely distributed. The second [8] (Fig. 8) closely resembles the former and has been detected and described more recently.

[7] *Celatoria diabroticae* Shimer. [8] *Chaetophleps setosa* Coq.

Four kinds of predatory bugs [9] have been observed destroying the beetles. The bug inserts its beak in a vulnerable spot and kills the beetle by injecting a poisonous fluid and by sapping its life blood.

A common kind of ground-beetle [10] has been repeatedly observed destroying the striped cucumber beetle in Indiana, but is not an important factor in holding this pest in check. The same statement may be made of the Carolina mantis.[11]

Another enemy, a mite,[12] develops frequently when plants attacked are grown under glass, especially in cold frames. These mites when abundant fasten themselves to the body of the beetle, rendering locomotion difficult, if not impossible. Two parasitic fungi destroy this insect.[13] The former attacks the beetles; the latter, the larvæ. The beetles are also infested by parasitic worms called nemas.[14]

A number of bird enemies are known to feed upon the striped cucumber beetle. Among these are the nighthawk, phœbe, wood pewee, yellow-bellied flycatcher, gray flycatcher, least flycatcher, red-winged blackbird, starling, chewink, rose-breasted grosbeak, black-headed grosbeak, Carolina wren, hermit thrush, robin, and bluebird.

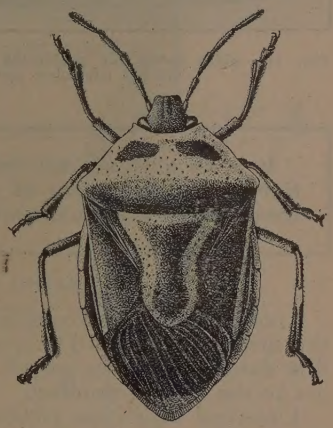

Fig. 9.—Double-eyed assassin bug, a predacious enemy of the striped cucumber beetle. Much enlarged.

METHODS OF CONTROL.

Direct applications of stomach poisons such as the arsenicals will destroy the beetles when they occur in moderate numbers, but have not proved entirely effective when they are very abundant; hence, recourse must be had to preventives, deterrent or contact poisons, and cultural methods.

Since the larvæ live in the roots and main stems, principally underground, it is difficult if not impossible to destroy them by any insecticide or other substance which would not at the same time injure the plants.

COVERING YOUNG PLANTS.

As a preventive of injury to young plants in the home garden early in the season, coverings are used. Barrel hoops cut in half, covered with screen wire, and put in the ground, may be used to protect the plants until they begin to run. Two strong wires bent in the form of croquet arches can be used for this purpose. The frame is covered with gauze or similar material of close mesh, so

[9] *Sinea diadema* Fab., *Perillus bioculatus* Fab. (fig. 9), *Podisus maculiventris* Say, and *Nabis ferus* L.

[10] *Pterostichus lucublandus* Say.

[11] *Stagmomantis carolina* Johann.

[12] *Uropoda* sp.

[13] *Metarrhizium anisopliae* Metsch. and *Beauveria globulifera* Pic.

[14] *Howardula benigna* Cobb has been observed to have this habit.

that the beetles can not work through it, and is held in place by earth packed about the edges to prevent the beetles from getting under it. Dish covers of wire gauze, such as are used for the protection of food from house flies (Fig. 10), serve the same purpose. When removed from the field they should be stored in a dry place, otherwise the gauze soon rusts.

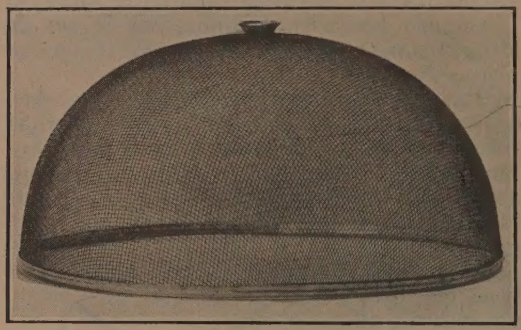

FIG. 10.—Wire cover for protecting plants against the striped cucumber beetle.

The forms of covering just advised appear to be the ones most easily prepared, most available, and most serviceable.

It is an absolute necessity that the covering employed fit tightly to the ground at every point to prevent the beetles from burrowing underneath.

PLANTING AN EXCESS OF SEED.

Another preventive consists in planting an excess of seed. By this method attack will be less concentrated and severe, and after the first danger period is passed the plants in each hill can be thinned out to the desired number.

A method which has yielded good results in some regions consists in planting the seeds in squares, one each week, as shown in the diagram. Frequently the first plant (1) is killed, and this may be the fate of the second (2), and sometimes even of the third (3). As long as the insects are seen they are poisoned, and this is continued until a stand of plants is obtained, as it is seldom that all four plantings are destroyed.

1	2
3	4

DUSTING WITH NICOTINE DUST.

Nicotine dust, a mixture of nicotine sulphate (liquid), hydrated lime, and a carrier, preferably kaolin or china clay, has been more successful in effecting control of the striped cucumber beetle than any other remedy thus far tested by the Bureau of Entomology. This dust may be prepared by the grower, and may contain any necessary proportion of nicotine.

FORMULAS TO USE.

For the control of the striped cucumber beetle, a dust containing 1.6 per cent of nicotine or its equivalent (4 per cent of nicotine sulphate containing 40 per cent nicotine) is effective. For the prepara-

tion of nicotine dust of this strength, either of the following formulas may be used, depending upon the amount required:

To make 100 pounds for field use:		
First formula—		
Hydrated lime	pounds	96
Nicotine sulphate, containing 40 per cent nicotine	do	4
Second formula—		
Kaolin	do	72
Lime	do	24
Nicotine sulphate, containing 40 per cent nicotine	do	4
To make 12½ pounds for use in gardens:		
First formula—		
Hydrated lime	do	12
Nicotine sulphate, containing 40 per cent nicotine	ounces	8
Second formula—		
Kaolin	pounds	9
Lime	do	3
Nicotine sulphate, containing 40 per cent nicotine	ounces	8

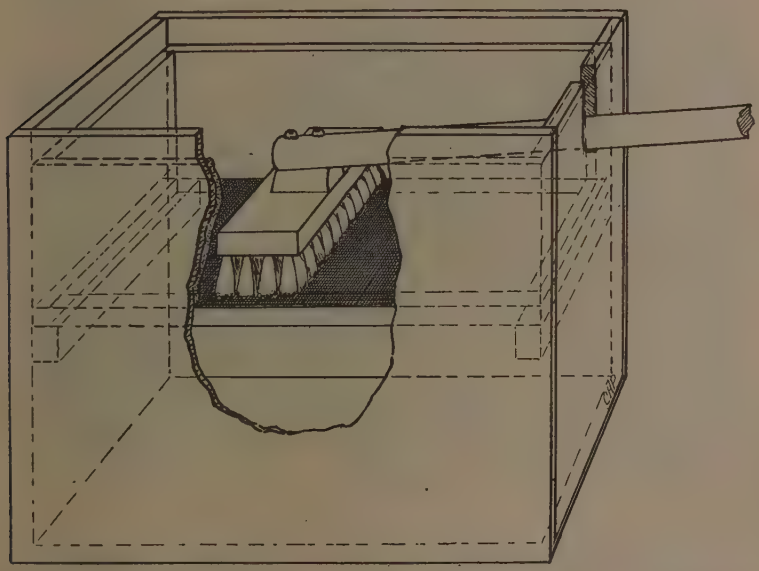

FIG. 11.—A mixer for use in the preparation of small quantities of nicotine dust. (White.)

PREPARING THE DUST.

In the preparation of the dust a thorough mixture of the nicotine sulphate with the carrier is essential. A convenient way of securing good results in preparing small quantities is to sprinkle the nicotine sulphate into the dust from a fruit jar with a perforated metal cap, at the same time stirring constantly. The resulting mixture, before use, should be resifted three or more times, with the aid of a brush, through a sieve having at least 20 meshes to the linear inch.

A very satisfactory and simple method of mixing the dust consists in the use of a box with a loose cover in which a sieve is placed and an ordinary floor brush with a handle is attached (Fig. 11). A slot is cut in the side of the box

so as to allow operation of the brush with the cover on. The cover to a large extent prevents the escape of the dust during the mixing process, and consequent inconvenience to the operator.

The dimensions of a box in which 12½ pounds of the dust can be conveniently mixed are as follows: Length, 15 inches; width, 10 inches; depth, 12 inches.

The sieve is constructed of brass screen, 20 meshes to the inch, tacked to a frame 4 inches deep.

The sieve fits snugly inside of the box and rests on a strip 5½ inches from the upper edge of the box.

The brush is an ordinary floor brush with edge trimmed off so that the corners and edges of the sieve may be reached.

The handle, 20 inches long, attached at right angles to the brush, is so constructed that the brush will rest in a level position over the entire length of the sieve and that the end of the handle will come through a slot in the upper end of the box.[15]

FIG. 12.—A good type of knapsack bellows duster to use in control of the striped cucumber beetle. (White.)

DUSTERS TO USE.

For the application of this dust, the most effective machine for small areas is of the knapsack bellows type (Fig. 12), and the best application is made, as far as results are concerned, by applying it thick enough to form a good covering on the plants and on the surface of the ground about the base. The dust may also be applied by means of a cheese-cloth sack (Fig. 13), held over the infested plants and the dust jarred therefrom as the operator passes up and down the rows.

HOW TO APPLY THE DUST.

One-fourth to one-half ounce to the hill is sufficient for one application. It must be applied so that the plant will be well covered, and the application should be made as soon as plants appear above

[15] White, W. H., Nicotine Dust for Control of the Striped Cucumber Beetle. (A Preliminary Report.) Department Circular 224, U. S. Dept. of Agriculture, p. 8. 1922.

ground, since the insect makes its first appearance suddenly, frequently in large numbers, and serious damage may result if the early application is neglected. Later applications are necessary in case of unusual abundance of the beetles or of adverse atmospheric conditions, such as wet weather. The plants and the soil at their bases must be kept well covered until after all danger of injury is passed In the vicinity of the District of Columbia this period is normally about three weeks, which will hold for other regions of similar climate.

ACTION OF NICOTINE DUST.

The nicotine dust acts both as a repellent and as a contact insecticide, and, properly applied, drives the beetles from the cracks in the soil about the bases of the plants where they rest and feed, and more or less completely coats their bodies, thus preventing them from escaping by flight, or disables or kills them after they have flown only a short distance. If applied in time the nicotine dust affords practically complete protection to young cucurbits against the striped cucumber beetle.

FIG. 13.—Dusting cucurbits with a cheese-cloth bag for control of the striped cucumber beetle. (White.)

SPRAYING WITH ARSENATE OF LEAD.

Lead arsenate has been tested against the striped cucumber beetle under different local and other conditions, and has proved effective. It adheres to the plants better than Paris green; hence it is more useful where rains occur at the time of application. Where cucumbers are transplanted, tests should be continued as to the value of insecticides and fungicides combined, and of lead arsenate alone, as a dip for the plants before setting them out. It should be used at the weaker strength at first, and afterwards, if found desirable, at a greater strength; not, however, in excess of 2 pounds (dry or powder) in 25 gallons of water.

It is an efficient protective and injures the plants of cucumber and squash less than any other of several arsenical preparations tried. A spray of 1½ pounds of the dry arsenical to 50 gallons of water has proved as successful as one of 6 pounds to 50 gallons.

In connection with lead-arsenate sprays the employment of trap crops is advisable (see p. 14). After the plants of the main crop

begin to run, it is advisable to spray them with Bordeaux mixture, prepared according to the 4–4–50 formula.

Lead arsenate has the following advantages over Paris green: (1) It contains less soluble arsenic and therefore is less harmful to growing plants and when applied properly at the correct strength does not scorch them; (2) it adheres more strongly to the foliage; (3) it leaves a white coating on the foliage, so that its presence or absence can be determined readily after spraying. When properly sprayed, treated plants have the appearance illustrated in Figure 14.

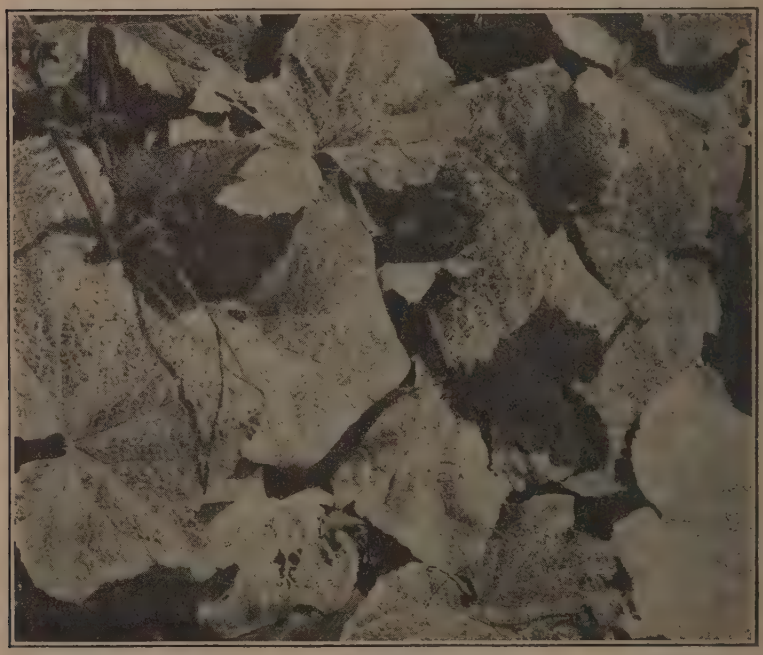

FIG. 14.—Cucumber leaves sprayed with Bordeaux-arsenate of lead for protection against the striped cucumber beetle.

The formula is as follows:

Arsenate of lead (powder)_____pounds__	3 or 1½
Water, or Bordeaux mixture (4–4–50 formula)__gallons__	50 or 25

For small gardens use two-thirds of an ounce, or 10 level teaspoonfuls, of the powder to a gallon of water.

SPRAYING WITH BORDEAUX MIXTURE.

Bordeaux mixture, a combination of copper sulphate (bluestone) and stone lime or quicklime in solution, is a standard fungicide and a valuable repellent against certain leaf-feeding beetles. It also acts

as a preventive of arsenical injury in spray mixtures. Its usefulness in the protection of cucumbers against the striped cucumber beetle warrants its employment in arsenical sprays against this pest. It may be prepared, according to the 4–4–50 formula, for home use as follows:

Provide two barrels, each of which should contain 25 gallons of water. Near the top of the water in one, suspend 25 pounds of copper sulphate in a burlap bag, allowing it to remain until dissolved. In the other slake an equal quantity of quicklime or stone lime. These form the stock solutions in such proportion that a gallon of liquid contains a pound of the chemical.

After thorough stirring, pour 2 gallons of the copper-sulphate solution and 10¼ gallons of water into a wooden container. In a similar container mix 2 gallons of milk of lime with 10¼ gallons of water. Pour these together, into the sprayer tank, through a brass wire strainer of not less than 18 meshes to the inch, thus making 25 gallons of Bordeaux mixture.

DIRECTIONS FOR SPRAYING.

Two or three sprayings ordinarily suffice for the overwintered beetles, and about the same number should be employed for the first new generation. One or two sprayings for the second generation, where it appears, also should be given. The first spray should be applied **as soon as the plants come up**, and the others at intervals of about a week, and just as the beetles of the first new brood appear and those of the second.

Applications of all poisonous preparations must be repeated when rainfall necessitates their renewal, until the plants have obtained a good start or the insects have dispersed. Arsenicals alone are not generally to be relied upon when the beetles are exceedingly numerous. One reason for this is that the beetles avoid the poisoned leaves and attack new growth or parts of plants which have not been covered completely by the spray mixture.

For success with any arsenical, every part of the plant must be coated—the upper and lower surfaces of the leaves and, above all, the vines and stalks, especially at the base—because when the beetles are abundant their feeding has the effect of girdling the plants near the base, even an inch under the surface of the ground.

In case Bordeaux mixture is sprayed on the plants as a protection against fungous diseases, lead arsenate should be added to protect the plants against leaf-eating insects, according to the formula given on page 12.

SPRAYERS TO USE.

For spraying against the striped cucumber beetle a compressed-air sprayer of about 3 or 4 gallons capacity (see Fig. 15) is considered the best for use in small gardens or in patches of from one-half acre to 2 acres, and is suitable even in somewhat larger fields,

where labor is abundant and cheap. For larger fields, however, sprayers of the wheelbarrow or barrel type, handled by two men, are preferable. The method of applying the arsenical with a wheelbarrow sprayer is shown in Figure 16.

DUSTING WITH DRY ARSENICALS.

Lead arsenate and other arsenicals, alone or mixed with plaster or lime dust in the proportion of 1:10 to 1:25 by weight, and dusted over the plants, effectually protect them in many cases. They are no more effective than a spray, but may be employed more quickly and where water is not readily accessible.

FIG. 15. — Compressed-air sprayer standing upright, showing hose, nozzle, and other attachments.

STIMULATING GROWTH AND KEEPING PLANTS IN CONDITION.

Injury to crops may be lessened by stimulating growth through generous applications of manure or commercial fertilizers and by frequent cultivation, which help the plants to outgrow attack. In parts of the South fish scrap is used as a fertilizer and is considered by many growers a useful deterrent of this and other insects attacking cucurbits. Frequent watering of the plants, by irrigation or with a cart or hose, is of great value, especially during dry weather, when they are seen to be wilting.

The plants should be examined carefully from time to time and kept free from the twelve-spotted cucumber beetle,[16] melon aphis,[17] squash-vine borer,[18] and other insects, since the aggregate injury to the vines by these pests renders the plants much more likely to succumb to the attack of the cucumber beetle on the foliage and of its larvæ at the roots.

CLEAN CULTURE AND USE OF TRAP PLANTS.

Injury from this as well as other cucurbit insects can be prevented largely by close attention to clean methods of cultivation. As soon as a crop is harvested the remnants should be raked into piles, covered with straw or other inflammable material, and burned. It is advisable, however, to leave standing here and there throughout the fields a few plants, such as those that might be desired for seed, upon which the insects that have not been reached by the fire may concentrate. Here the beetles can be easily destroyed with kerosene or a plumber's torch. As traps for the last generation, plant later or use later varieties.

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[16] *Diabrotica 12-punctata* Fab. [17] *Aphis gossypii* Glov. [18] *Melittia satyriniformis* Hübn.

Late beans attract the beetles after the cucurbit crop has been made. The cooperation of cucurbit growers in the destruction of the fall brood of beetles would accomplish much in a few years, at least in some regions.

Any early squash may be planted as an early trap crop. Gourds planted in the vicinity of late cucumbers and melons act successfully as traps when the beetles are abundant. Pumpkins and squashes, being more hardy than other cucurbits, are especially serviceable for this purpose, as they withstand insect attack better. As

FIG. 16.—Spraying cucumbers with Bordeaux-arsenate of lead mixture by means of wheelbarrow sprayer.

an example of the attractiveness of these traps, about 50,000 beetles were collected for experimental purposes from such crops in a few days at the Bureau of Entomology station in Wisconsin.

INEFFECTIVE AND DOUBTFUL REMEDIES.

Pyrethrum insect powder, while fairly successful, is too expensive for use on a large scale. Naphthalene, in the form of flakes or camphor balls, as a deterrent is prohibitive for the same reason. Land plaster or gypsum and air-slaked lime saturated with kerosene or turpentine have been used as repellents but have never been claimed as of specific value. Dusting with air-slaked lime is in the same category. Such substances as charcoal, soot, road dust, saltpeter, and cow manure are not effective as repellents, and hellebore is not a useful insecticide against this beetle. Transplanting from frames or hothouses, while theoretically of value in establishing the plants so as to get ahead of the beetle, is not usually successful.

Zinc arsenite and calcium arsenate have not proved as desirable as lead arsenate.

SUMMARY OF CONTROL MEASURES.

The control measures which have given the greatest promise of success against the striped cucumber beetle are preventives, repellents, farm practice, and the use of insecticides. These may be summarized as follows:

In small gardens protect young and choice plants with coverings. These are useful only when the greatest care is observed to make them tight enough to keep out the beetles.

Plant an excess of seed, to distribute attack. This should always be done.

At the first appearance of the beetle apply nicotine dust containing 4 per cent nicotine sulphate by means of a knapsack bellows duster or a cheesecloth sack, with special attention to hitting the insects.

While the last-mentioned remedy is the best known direct method, additional experiments are desirable on spraying with lead arsenate, either alone or in combination with Bordeaux mixture, care being taken to cover every portion of infested plants, both surfaces of the leaves, the vines, and the stems.

Practice clean culture in connection with trap plants, such as beans, gourds, and early or late varieties of squash and pumpkin.

Stimulate the growth of plants by manures and other fertilizers, water them in drought and in hot weather, and keep them free from other insects and from disease.

Secure the active cooperation of neighboring growers of cucurbits in such of these methods as are possible. Community effort in the observance of these methods will in time undoubtedly lessen the danger of losses from this pest.

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